



Sensors

Robust Sensors Detect Ablation in TPS Materials

Embedded and arrayed temperature sensors and capacitor networks allow large-scale sensing

Innovators at NASA's Glenn Research Center have developed new sensors that can be integrated into thermal protection systems (TPS) to protect them from environmental damage. Radiation, shock, and ablation (erosion of the protective outer surface) combine to damage the TPS material, so it becomes crucial to determine the temperature and rate at which the TPS material deteriorates. Glenn has developed an improved method to bulk-manufacture silicon carbide (SiC) devices that enables sensors to be manufactured economically. Additionally, this technique permits the simultaneous production of SiC sensors of different types (e.g., pressure sensors, flow sensors, and accelerometers) from the same SiC wafer. Glenn's development holds great potential for any industry that requires sensors and monitoring of temperature, corrosion, or environmental damage.

BENEFITS

- ➔ Efficient: Integrates TPS material manufacturing with embedded sensor and telemetry instrumentation
- ➔ Time-saving: Eliminates the expensive and time-consuming practice of manually inserting thermocouples and resistors into TPS material
- ➔ Economic fabrication: Bulk manufacture of SiC-based sensors
- ➔ Versatile: Allows numerous sensors to be embedded and arrayed for high resolution and/or large-area profiling

technology solution

NASA Technology Transfer Program

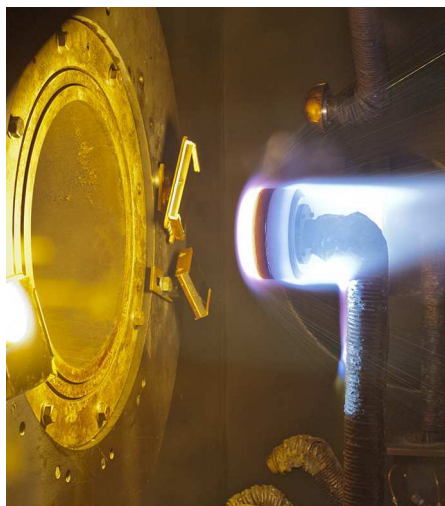
Bringing NASA Technology Down to Earth

THE TECHNOLOGY

The current method for incorporating instrumentation into the TPS is a costly and inefficient process that involves inserting conventional thermocouples and resistors into the TPS materials. First, the standard thermocouples and resistors are manually placed into cylindrical plugs made from the same material as the TPS, and these plugs are then inserted into holes drilled into the main TPS material that is incorporated into the aero-shell. These are time-consuming and costly processes. This approach limits the number of sensors that can be integrated into the TPS, and makes impossible any high-resolution, large-area tomographic profile of the TPS. Glenn's breakthrough technology allows micron-scale sensors to be embedded and arrayed, during the manufacturing process, within a large surface area of the TPS material, eliminating the plug approach. With this method, the machining, manual insertion, and gluing necessary to integrate these vital sensors is eliminated, and a greater number of sensors can be incorporated into the TPS. Recent advances in bulk manufacturing of SiC-based sensors have facilitated new processes for manufacturing and integrating sensors. Glenn's innovators have successfully developed three ways to improve the bulk manufacture of microelectromechanical systems (MEMS) devices. The first involves the use of a process flow reversal in which the metallization is applied first, before any apertures or recesses are etched into or through the SiC wafer. This technique permits the simultaneous production of multifunctional products on a single SiC wafer, thereby greatly lowering capital equipment and production cost. A second innovation leveraged this bulk-manufacturing capability to produce a multifunctional MEMS SiC accelerometer. Finally, Glenn scientists invented a system for embedding multiple sensors with arrays of processors or capacitor strips that relay information about the condition of the TPS material. Other features can be added during manufacturing, such as telemetry networks, or thermoelectric devices that harvest energy from the TPS.



This technology can identify dangerous degradation in a trucks brake system



Glenn's sensors withstand the heat and pressure conditions of atmospheric re-entry

APPLICATIONS

The technology has several potential applications:

- Brake material in vehicles
- Fire protection systems on ships and other vessels
- Aerospace
- TPS systems for space vehicles and payloads
- Any industry that monitors corrosion, erosion, ablation, recession, acceleration, pressure, or surface temperature

PUBLICATIONS

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Patent Pending

National Aeronautics and Space Administration

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